

REMARKS/ARGUMENTS

Claims 16-36 are pending, and are unamended.

A. Response to Examiner's Response to Arguments

In response to Applicants' argument that Fig. 1b of Onuki et al. clearly shows no overlap between the bias voltage and the sputtering power, the Examiner asserts that at a minimum, Onuki's disclosure taken as a whole teaches that it would have been obvious to one of ordinary skill in the art to apply Onuki's conventional sputtering recursively as shown in Onuki's Figure 1b.

The lack of overlap in Fig. 1b of Onuki et al. supports Applicants' argument that the claims are patentable because, for instance, the references do not teach or suggest maintaining a plasma by coupling sputtering energy into the processing chamber to deposit a first layer of a film on a substrate by sputtering without biasing the plasma toward the substrate and, thereafter, maintaining the plasma by maintaining coupling of the sputtering energy into the chamber and biasing the plasma toward the substrate to deposit a second layer of the film over the first layer. Onuki et al. specifically discloses terminating the sputtering power during application of the bias voltage. This is demonstrated by the fact that there is no overlap between the bias voltage and the sputtering power in Figure 1b.

In response to Applicants' argument that Onuki et al. specifically discloses terminating the sputtering power during application of the bias voltage, the Examiner states that the right portion of Onuki's Figure 1a shows applying sputtering power and bias voltage at the same time.

The Examiner's statement is inapposite. The Examiner relies on the switching bias sputtering Figure 1b in Onuki et al. for allegedly disclosing the claimed feature. On the other hand, Figure 1a shows conventional DC sputtering and conventional DC bias sputtering. The Examiner alleges: "It is not clear in Jim Onuki's Figure 1a and accompanying text that

Onuki's conventional sputtering is one complete process, distinct processes, or is a process applied recursively. However, Jim Onuki's disclosure, taken as a whole, teaches that it would have been obvious to one of ordinary skill in the art to apply Jim Onuki's conventional sputtering recursively as shown in Onuki's Figure 1b." Onuki et al. discloses switching bias sputtering (Figure 1b) in contrast with conventional sputtering (Figure 1a). Nothing in Onuki et al. suggests the recursive conventional sputtering process proposed by the Examiner.

The Examiner further alleges: "Applicant states that neither Onuki nor Boys teach depositing plural layers of thin films." Applicants did not make such a statement. Applicants did state: "Boys et al. does not teach a controller or a memory storing a program for directing the operation of the system to deposit a first layer without biasing of the plasma and a second layer with biasing of the plasma."

In response to Applicants' argument that claim 32 is patentable because neither Boys et al. nor Onuki et al. discloses or suggests a controller or a memory storing a program for directing the operation of the system to deposit a first layer without biasing of the plasma and a second layer with biasing of the plasma, the Examiner states: "That Onuki and Boys et al are not clear in teaching ' . . . deposit a first layer without biasing of the plasma and a second layer with biasing of the plasma . . . ' is well established. The Examiner has proposed a 102(b)/103(a) rejection in this regard in view of Onuki solely."

Claim 32 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Boys et al. in view of Onuki et al. The Examiner agrees that Onuki et al. and Boys et al. do not teach depositing a first layer without biasing of the plasma and a second layer with biasing of the plasma. As discussed herein, Onuki et al. does not suggest this claimed feature.

With regard to the rejection of claim 20, the Examiner again relies on Onuki et al. for suggesting depositing a first layer by sputtering without biasing the plasma and then depositing a second layer over the first layer by sputtering and biasing the plasma, which Onuki et al. fails to do.

With regard to the rejection of claim 23 under 35 U.S.C. § 103(a) as being unpatentable over Onuki et al. in view of Matsuura, the Examiner alleges that "the sole difference between the claimed invention and the above conveyed prior art is the lack of intended use in Applicant's product claim." The claim limitation at issue is "at least one insulating layer formed between said metal layer and said semiconductor substrate, said insulating layer having a plurality of patterned holes filled with electrically conductive material to electrically connect selected portions of said metal layer to selected portions of said semiconductor substrate, wherein said insulating layer comprises a first silicon oxide layer and a second silicon oxide layer; said first and said second silicon oxide layers deposited using a high-density plasma chemical vapor deposition process, said first silicon oxide layer deposited for the reduction of mechanical stress in said second silicon oxide layer." The Examiner has not pointed to anything in the references that would suggest the claimed invention. Onuki et al. does not teach depositing silicon oxide layers. Matsuura discloses silicon oxide layers, but fails to teach or suggest a first silicon oxide layer deposited for reduction of mechanical stress in the second silicon oxide layer. Although Onuki et al. at Fig. 4 shows a SiO₂ layer, it is "thermally grown," not by high-density plasma chemical vapor deposition process. In addition, Onuki et al. does not teach or suggest two silicon oxide layers, wherein the first silicon oxide layer is deposited for the reduction of mechanical stress in the second silicon oxide layer. The references do not, individually or combined, teach or suggest depositing first and second silicon oxide layers by high-density plasma chemical vapor deposition, where a first silicon oxide layer deposited for reduction of mechanical stress in the second silicon oxide layer. The claim features not taught or suggested in Onuki et al. and Matsuura are not merely intended use features.

B. Response to Rejections

Claims 28 and 30 are objected to because claim 28 depends from claim 30 which is a higher numbered claim. Applicants note that this is a pending patent application being prosecuted, **not** an issued patent. At issuance, the claim numbers will be renumbered.

In rejecting the claims, the Examiner relies on Onuki et al. for allegedly disclosing maintaining a plasma by coupling sputtering energy into the processing chamber to deposit a first layer of a film on a substrate by sputtering without biasing the plasma toward the substrate and, thereafter, maintaining the plasma by maintaining coupling of the sputtering energy into the chamber and biasing the plasma toward the substrate to deposit a second layer of the film over the first layer. Onuki et al., however, specifically discloses terminating the sputtering power during application of the bias voltage.

The Examiner points to Fig. 1(a) in Onuki et al. for the disclosure of maintaining the application of the sputtering power while biasing the plasma toward the substrate. In the Advisory Action dated January 5, 2001, the Examiner asserts: "It has been well demonstrated that Onuki et al teach the method limitations of claim 16 with reference to Fig. 1a,b. Fig. 1a,b teach both zero and non-zero bias voltages repeated between 1 and 18 cycles providing multiple layers (Section 2.1)."

Fig. 1b clearly shows no overlap between the bias voltage and the sputtering power. Fig. 1a merely shows a conventional DC sputtering with 4kW sputtering power and zero bias voltage, and conventional DC bias sputtering with 4kW sputtering power and -200V bias voltage. Nothing in Onuki et al., however, teaches or suggests combining or alternating the conventional DC sputtering and DC bias sputtering. As to the 18 cycles mentioned in the Examiner's statement, Onuki et al. actually states: "In the case of one-step switching bias sputtering, a cycle consisted of 5 s d.c. and 5 s d.c. bias sputtering. A cycle was repeated 18 times for the formation of 0.5 μm thick Al-0.5wt.%Cu-1wt.%Si films." This relates to the one-step switching bias sputtering shown in Fig. 1b in which there is no overlap between the sputtering power and the bias voltage. It has nothing to do with the conventional DC sputtering and conventional DC bias sputtering shown in Fig. 1a. Clearly, the Examiner has misconstrued Onuki et al.

Claim 16

Claim 16 stands rejected under 35 U.S.C. § 102(b) as being anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as obvious over, Onuki et al. Onuki et al. does not disclose or suggest every element of claim 16.

Onuki et al. discloses a switching bias sputtering process whereby d.c. sputtering and d.c. bias sputtering are operated alternately (page 182, right column, lines 9-11). As illustrated in Figs. 1 and 2, the switching bias sputtering process involves alternating step pulses of sputtering power and bias voltage. The step pulses of sputtering power and bias voltage alternate, and do not overlap in time. The use of the switching bias sputtering method is intended to enhance the step coverage and quality of Al films (page 182, right column, lines 12-13).

As discussed above, Onuki et al. does not disclose or suggest maintaining a plasma by coupling sputtering energy into the processing chamber to deposit a first layer of a film on a substrate by sputtering without biasing the plasma toward the substrate and, thereafter, maintaining the plasma by maintaining coupling of the sputtering energy into the chamber and biasing the plasma toward the substrate to deposit a second layer of the film over the first layer. Onuki et al. specifically discloses terminating the sputtering power during application of the bias voltage.

The Examiner misconstrues Onuki et al., including the teachings of Fig. 1a,b, to arrive at the erroneous conclusion that Onuki et al. anticipates or renders obvious claim 16. Claim 16 recites depositing a first layer by sputtering without biasing the plasma and then depositing a second layer over the first layer by sputtering and biasing the plasma. Onuki et al. clearly does not teach depositing the two different layers. Nor does Onuki et al. recognize that the first layer formed without biasing the plasma is a reduced stress layer for reducing the stress of films deposited on the substrate (Page 4, lines 1-3 and Abstract). Therefore, claim 16 is novel and patentable over Onuki et al.

The Examiner makes the conclusory allegation that Onuki et al., taken as a whole, teaches that it would have been obvious to apply its conventional sputtering recursively as shown in Figure 1b, and states: "Motivation for a person of ordinary skill in the art to apply Jin Onuki's conventional sputtering recursively as shown in Onuki's Figure 1b is for controlling the argon content in the deposited films as taught by Onuki (left column; Page 184)." This, however, does not address the problem that Onuki et al. does not disclose or suggest maintaining a plasma by coupling sputtering energy into the processing chamber to deposit a first layer of a film on a substrate by sputtering without biasing the plasma toward the substrate and, thereafter, maintaining the plasma by maintaining coupling of the sputtering energy into the chamber and biasing the plasma toward the substrate to deposit a second layer of the film over the first layer.

Claims 17-19, 31, and 32

Claims 17-19, 31, and 32 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Boys et al. (USP 4,500,408) in view of Onuki et al. The Examiner recognizes that Boys et al. does not teach sputtering without biasing plasma toward the substrate. The Examiner relies on Onuki et al. for allegedly disclosing the deposition of a first layer without biasing and a second layer with biasing.

As discussed above, however, Onuki et al. specifically discloses terminating the sputtering power during application of the bias voltage. Onuki et al. is devoid of any teaching or suggestion for depositing a first layer by sputtering without biasing the plasma and then depositing a second layer over the first layer by sputtering and biasing the plasma.

In addition, claim 18 further recites that the program includes instructions for depositing a plurality of the first layers and second layers until the desired thickness of the film is reached. The references do not disclose or suggest depositing a plurality of first layers by sputtering without biasing the plasma and second layers by sputtering and biasing the plasma. Claim 19 depends from claim 17 and further recites silicon and oxygen in the process gas. Claim 31 depends from claim 19 and further recites that the source of silicon contains silane.

For at least the foregoing reasons, Applicants respectfully submit that independent claim 17 and claims 18, 19, and 31 depending therefrom are patentable.

Applicants respectfully assert that independent claim 32 is patentable over the cited references because, for instance, they do not teach or suggest a second set of computer instructions for controlling the plasma generation system to form a plasma from the process gas by coupling sputtering energy into said processing chamber to deposit a first layer of a film over a substrate by sputtering without biasing said plasma towards said substrate; and a third set of computer instructions for controlling said plasma generation system to maintain said plasma by maintaining coupling of said sputtering energy into said processing chamber and to bias said plasma toward said substrate to deposit a second layer of said film over said first layer.

The Examiner recognizes that Boys et al. does not teach a controller or a memory storing a program for directing the operation of the system to deposit a first layer without biasing of the plasma and a second layer with biasing of the plasma. The Examiner relies on Onuki et al. for allegedly disclosing the deposition of a first layer without biasing and a second layer with biasing.

As discussed above, however, Onuki et al. specifically discloses terminating the sputtering power during application of the bias voltage. Onuki et al. is devoid of any teaching or suggestion for depositing a first layer by sputtering without biasing the plasma and then depositing a second layer over the first layer by sputtering and biasing the plasma.

For at least the foregoing reasons, Applicants respectfully submit that claim 32 is patentable.

Claim 20

Claim 20 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Li et al. (USP 5,772,771) in view of Onuki et al. The Examiner recognizes that Li et al. do not teach a controller or a memory storing a program for directing the operation of the system to deposit a first layer without biasing of the plasma and a second layer with biasing of the plasma.

The Examiner relies on Onuki et al. for allegedly disclosing the deposition of a first layer without biasing and a second layer with biasing.

As discussed above, however, Onuki et al. specifically discloses terminating the sputtering power during application of the bias voltage. Onuki et al. is devoid of any teaching or suggestion for depositing a first layer by sputtering without biasing the plasma and then depositing a second layer over the first layer by sputtering and biasing the plasma. For at least the foregoing reasons, claim 20 is patentable.

Claims 21 and 22

Claims 21 and 22 depend from claim 20, and stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Li et al., and Onuki et al. in view of Boys et al. The Examiner cites Boys et al. for allegedly disclosing temperature and pressure control means. Boys et al., however, does not cure the deficiencies of Li et al. and Onuki et al., since Boys et al. also fails to teach a controller or a memory storing a program for directing the operation of the system to deposit a first layer without biasing of the plasma and a second layer with biasing of the plasma. Accordingly, claims 21 and 22 are patentable.

Claims 23, 24, and 36

Claims 23, 24, and 36 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Onuki et al. in view of Matsuura (USP 5,319,247).

Applicants respectfully assert that claim 23 is patentable over the references because, for instance, the references do not teach or suggest an insulating layer formed between the metal layer and the semiconductor substrate and including a first silicon oxide layer and a second silicon oxide layer deposited using a high-density plasma chemical vapor deposition process, where the first silicon oxide layer is deposited for the reduction of mechanical stress in the second silicon oxide layer.

Applicants respectfully assert that the Examiner has not established a *prima facie* case of obviousness, since the Examiner has not pointed to anything in the references that would

suggest the claimed invention. Onuki et al. does not teach depositing silicon oxide layers. Matsuura discloses silicon oxide layers, but fails to teach or suggest a first silicon oxide layer deposited for reduction of mechanical stress in the second silicon oxide layer.

Although Onuki et al. at Fig. 4 shows a SiO₂ layer, it is “thermally grown,” not by high-density plasma chemical vapor deposition process. In addition, Onuki et al. does not teach or suggest two silicon oxide layers, wherein the first silicon oxide layer is deposited for the reduction of mechanical stress in the second silicon oxide layer. The references do not, individually or combined, teach or suggest depositing first and second silicon oxide layers by high-density plasma chemical vapor deposition, where a first silicon oxide layer deposited for reduction of mechanical stress in the second silicon oxide layer.

Moreover, Applicants contend that the rejection based on the combination of the references benefits from the exercise of hindsight. The references are directed to very different processes for forming different films to achieve different purposes. For example, Onuki et al. is directed to forming sputtered Al and Al alloy films using switching bias sputtering involving d.c. sputtering and d.c. bias sputtering; while Matsuura relates to deposition of silicon oxide films by plasma CVD. There is no suggestion that the operating conditions for depositing silicon oxide layers in Matsuura can be combined with the switching bias sputtering technique taught in Onuki et al.

In addition, claim 24 further recites that a second metal layer is formed above the substrate and below the at least one insulating layer, and a second insulating layer is formed between the second metal layer and the substrate. Claim 36 further recites that the first silicon oxide layer is deposited on the substrate by applying a sputtering power to reactants to generate a plasma in a process chamber, and the second silicon oxide layer is deposited on the first silicon oxide layer by biasing the plasma toward the substrate while maintaining application of the sputtering power to the reactants. These features are also missing from the references.

For at least the foregoing reasons, Applicants respectfully assert that claim 23 and claims 24 and 36 depending therefrom are patentable.

Claims 25-30 and 33-35

Claims 25-30 and 33-35 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Boys et al. and Onuki et al. in view of Li et al. Li et al. is cited for allegedly disclosing plasma generation by an inductively coupled plasma.

Claims 25-30 depend from claim 17, and are submitted to be patentable at least due to their dependency from claim 17. Li et al. does not cure the deficiencies of Boys et al. and Onuki et al., since Li et al. also fails to teach depositing a first layer by sputtering without biasing the plasma and then depositing a second layer over the first layer by sputtering and biasing the plasma.

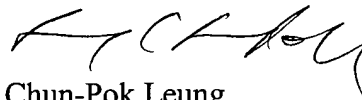
Claims 33-35 depend from claim 32, and are submitted to be patentable for at least the reasons that claim 32 is patentable as discussed above. For example, Li et al. does not disclose a controller or a memory storing a program for directing the operation of the system to deposit a first layer without biasing of the plasma and a second layer with biasing of the plasma.

CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance and an action to that end is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 650-326-2400.

Respectfully submitted,



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